# Space Weather Technical Forecast

Issued on Thursday, 26 January 2023 at 12:21 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: Ongoing likelihood of R1/R2 Radio Blackouts day 1, but easing thereafter. Slight chance of G1/Minor Storms, mainly day 1 and day 3 (26th and 28th).**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Moderate with two M-flares observed. Peak flare was M2.0 at 25/2235 UTC from AR3192 Cai/Beta. 3192 has now rotated off the west limb, as has 31090 which has a history of producing M class flares. There are a total of eight numbered sunspots and one unnumbered region, however, these groups are all small and magnetically simple. Flux emergence around AR3200 Cai/Beta has eased. No Earth-directed CMEs were detected in available imagery.

**Solar Wind / Geomagnetic Activity:** The solar wind has fluctuated significantly, mainly slightly elevated around 470km/s, but perhaps on a slow increasing trend. Density was average or slightly above. The total IMF, Bt, was mainly Weak to Moderate, occasionally reaching 9nT. The north-south component, Bz, was also generally weak, but did briefly reach +9nT, no lower than -7nT in the southward direction. The phi angle was mainly positive throughout, however (away from the Sun). Geomagnetic Activity was Quiet to Unsettled (Kp 1-3).

**Energetic Particles / Solar Radiation:** The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has been at Background levels throughout. High energy electron flux (greater than 2 MeV) has been at Background to Moderate. The associated 24-hour integrated electron fluence stayed well below the Active threshold, with 1.1e7 integrated pfu observed at 26/0001 UTC.

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# Met Office Space Weather Technical Forecast

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Moderate solar activity is likely to continue on day 1 (26th), before easing to mainly Low as active regions (3190 and 3192) which have recently rotated off the west limb move further away. These regions will continue to give a risk of observed M-flares, with a slight chance of X-flares day 1 and perhaps day 2 (26-27th). All other regions are currently smaller and magnetically simple, with only a slight chance of M-flares.

**Solar Wind / Geomagnetic Activity:** There are no Earth-directed CMEs in this forecast. Solar winds are expected to become elevated day 1 (26th) due to the arrival of the fast winds of CH69/+. A further transition into CH71/+ is then possible, most likely on day 3 (28th) bringing further elevated winds. Geomagnetic activity is expected to be Quiet with Unsettled spells for much of the period, but rising to Active with a slight chance of G1 Minor Storms. The greatest risk is on day 1 (26th) and day 3 (27th).

**Energetic Particles / Solar Radiation:** The high energy (greater than 10 MeV) proton flux observed by GOES16 is likely to remain at predominantly Background levels, but with a slight chance of reaching S1 or greater through the period. This risk is expected to ease day 3 (28th) onwards as AR3190 move further around the western limb. Electron flux is expected to be at Normal Background to Moderate levels at first, but likely rising later in the period response to any solar wind enhancements from the arrival of the fast winds of CH69 and CH70, This will bring a slight chance of Active fluence mainly day 3 (28th) onward.

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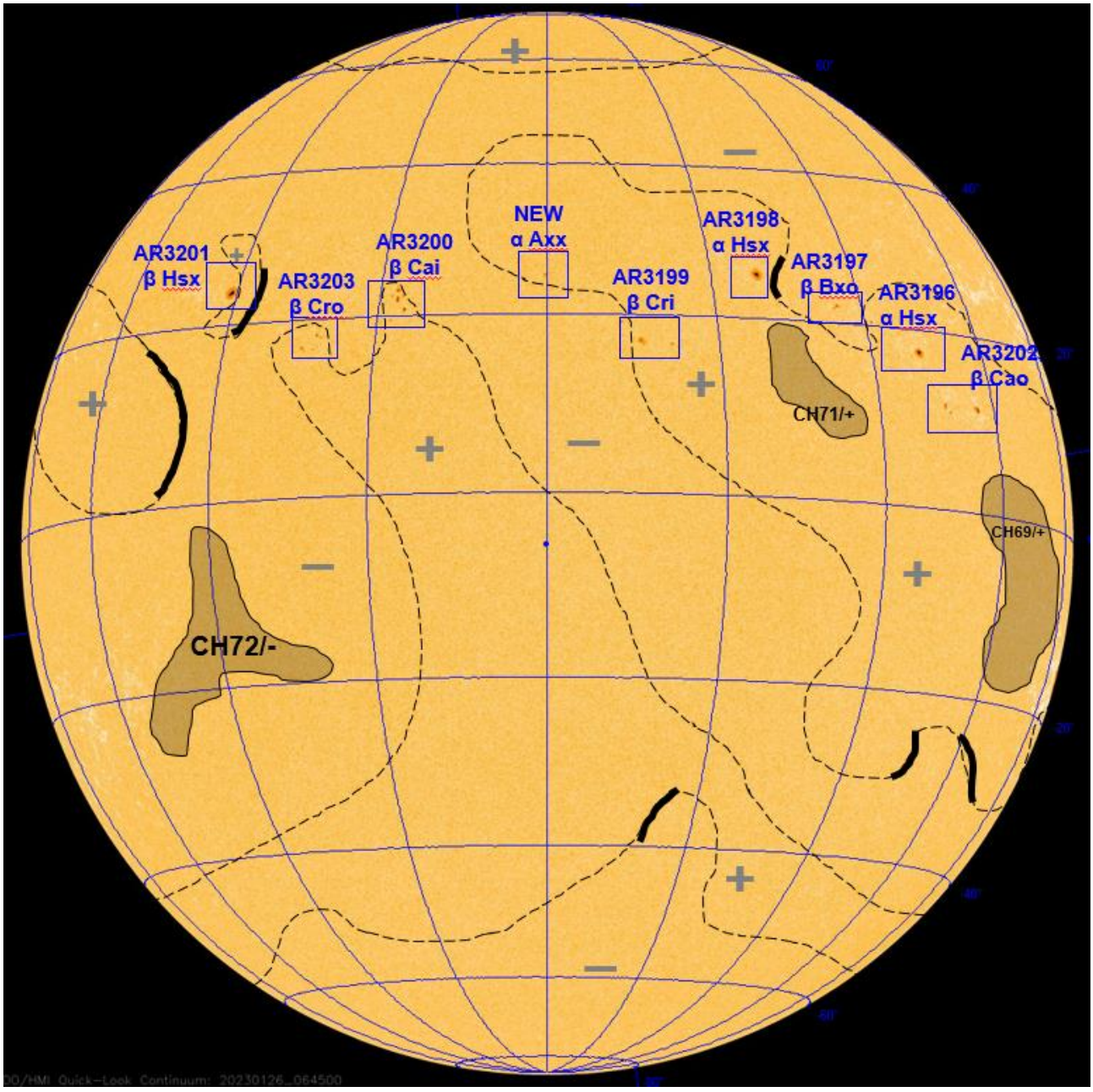
**Figure 1. Solar Analysis Valid 26/0700UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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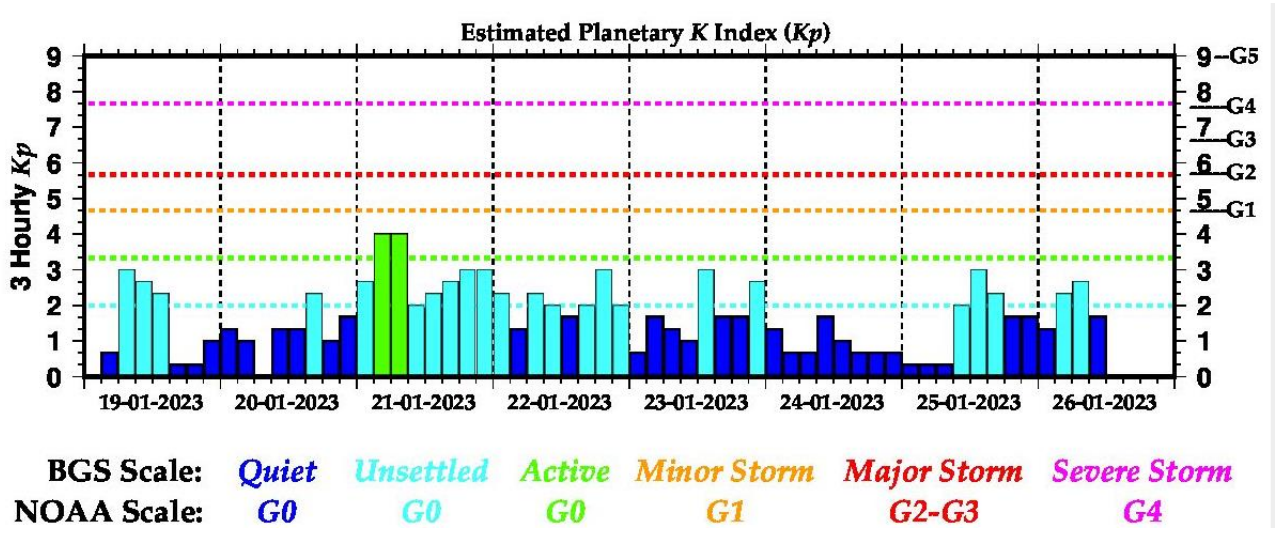
## Geomagnetic Storms:

The forecast period currently features no Earth-directed CMEs.
Earth is due to see the arrival of the CIR of CH69/+ on day 1 (26th), before a transition into what is likely to be a modest high speed stream (HSS), potentially reaching around 550 km/s. This timing is good confidence with a clear enhancement observed in STEREO A around 1300UTC on 25th, with Earth subsequently seeing similar conditions around 1-day after. This is likely to be followed by a further similar enhancement day 3 (28th) due to CH71/+, as shown in MOSWOC Enlil, although this is lower confidence
Geomagnetic activity is expected to be Quiet to Unsettled for much of the period, but rising to Active, with a slight chance of G1 Minor Storms, from the arrival of any coronal hole sourced fast winds, with the greatest risk on day 1 (26th) and day 3 (28th). However, with a period of slightly elevated to elevated winds expected, any passing transients will also bring a risk of Active spells throughout.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 20 | 10 | 20 | 10 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections- Nil

**Figure 2: Estimated Planetary Kp index from BGS**

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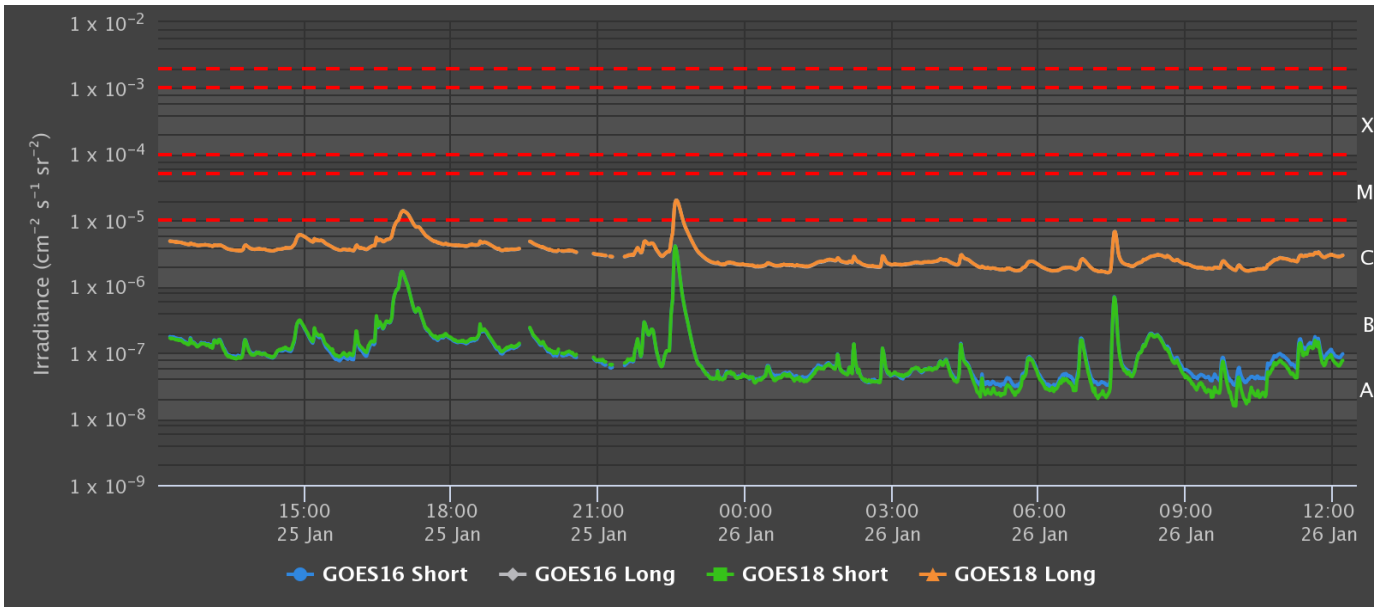
**Radio Blackouts - X-Ray Flares:**
Recent Moderate activity levels are expected to fall through the period, as despite the large number of small sunspots on the disc, the main sources of this activity, AR3190 and AR3192, will continue rotating away from the Earth-facing side.
There are a total of nine active regions, eight of which are currently numbered, they are all small and magnetically simple. All these regions are in the northern hemisphere. Far-sided products are however indicative of further regions rotating onto the disc, with a bright area on STEREO-A EUVI in the south, showing the likely return of ex-AR3181.
Overall, activity is likely to be Moderate with further M-flares on day 1 (26th), reducing to a chance thereafter, before declining to be a slight chance by day 4 (29th).

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | Yes | 60 | 40 | 30 | 20 |
| Very Active | R3 to R5 X Class | No | 10 | 5 | 1 | 1 |

**Figure 3:GOES18 X-Ray flares**

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## Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) protons as observed by GOES-16 are currently forecast to persist at background levels, but with a slight chance of rising in response to any significant flaring, and perhaps approaching the S1 level.
This is most likely to come from AR3190, which has now rotated over the western horizon and onto the far-side. Despite this, any notable flaring from this region will continue to bring a potential for increased proton flux, only gradually receding by day 3 (28th) onward. Despite the large number of other active regions on the disc, these are all smaller and simpler, with a lower risk of proton rich flaring.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 10 | 10 | 5 | 5 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

## High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) is expected to persist at Background to Moderate levels at first, before likely dropping out for a time later day 1 (26th) as Earth moves into the fast wind from CH69. As the outer Van Allen Belt recovers to GEO, flux levels are likely to return to Moderate levels, with a chance of reaching High, mainly during peak periods of the diurnal cycle. This is low confidence however, with a chance of further suppression in values on day 3 due to the arrival of CH70 fast winds.
The associated 24 hour fluence is forecast to stay below the Active threshold throughout, but with a slight chance of rising above through the period. This is supported by REFM which indicated a general flat trend throughout, however this doesn't take account of the expected solar wind enhancement forecast for day 1 (26th), so is unreliable beyond this.

| GEO Electron Environment Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 1 | 10 | 20 | 20 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

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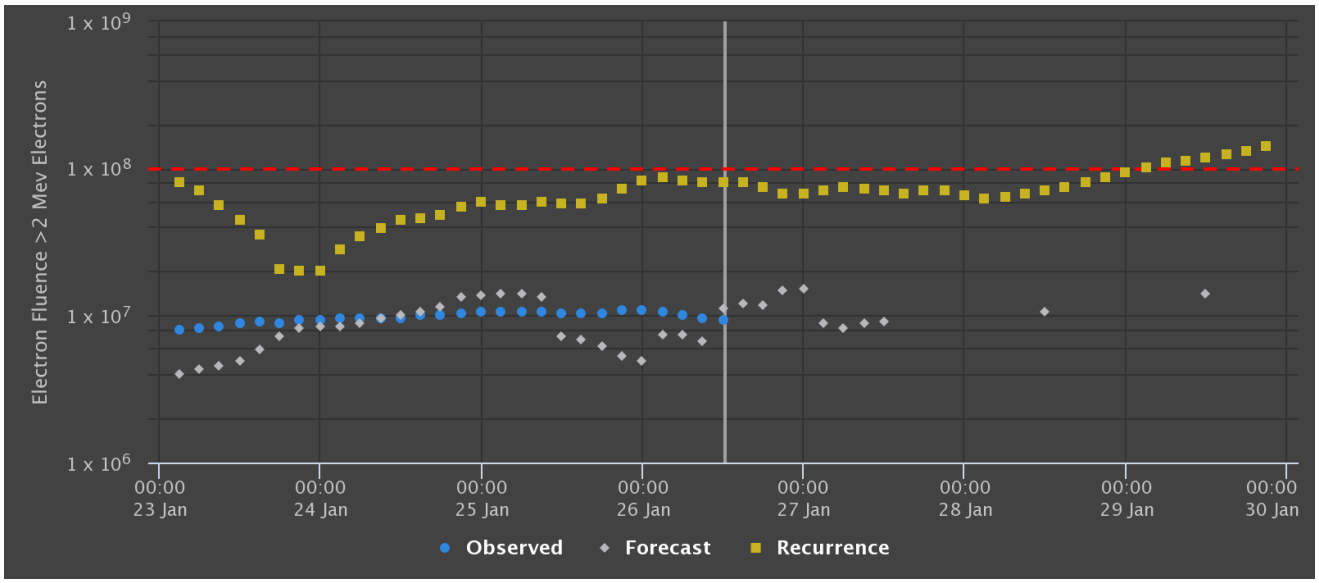
**Figure 4: MOSWOC REF Model. Fluence observed well below 1e8 Active level.**

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